Large Binocular Telescope Interferometer Science and Status

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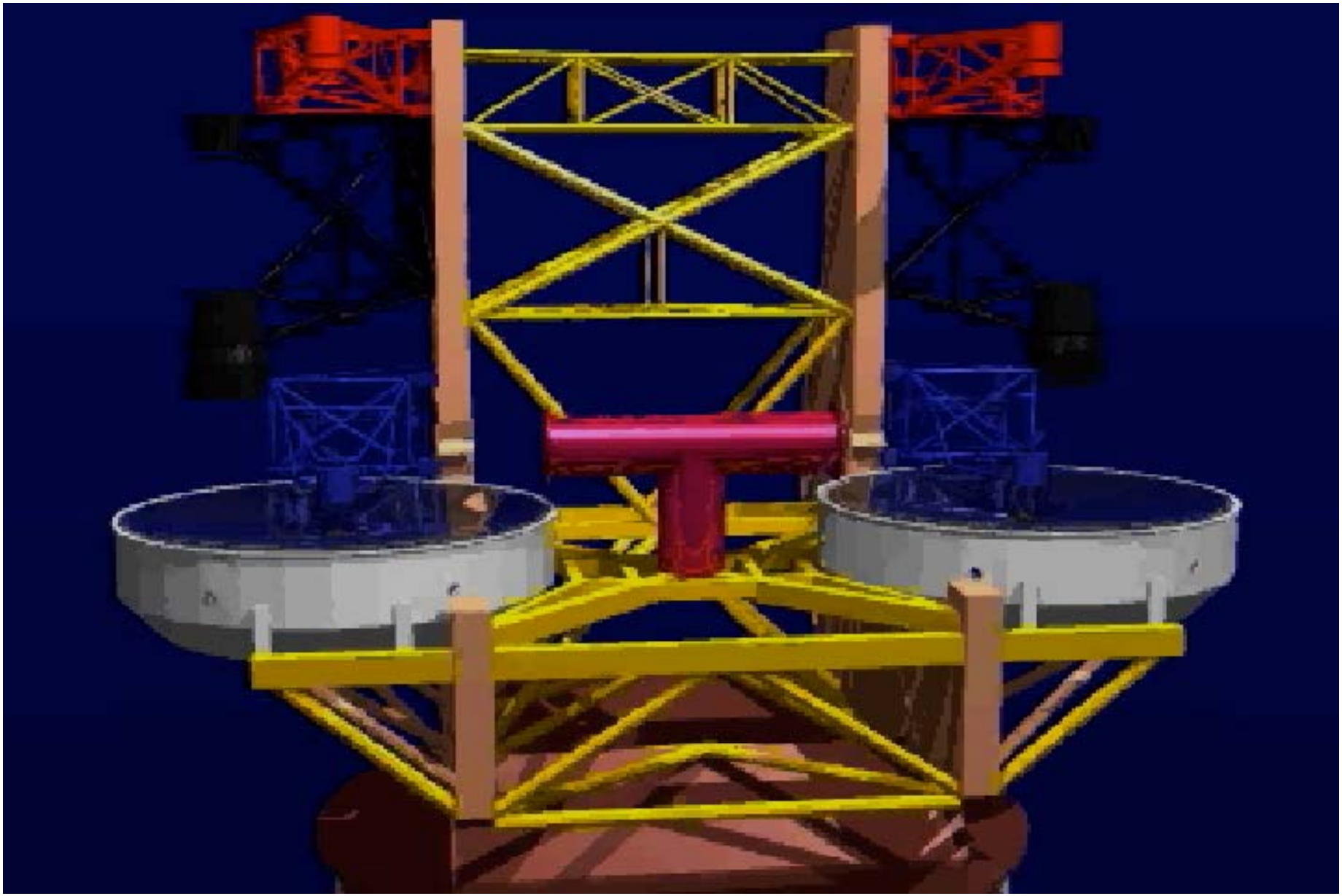
The Large Binocular Telescope



Goals of LBTI

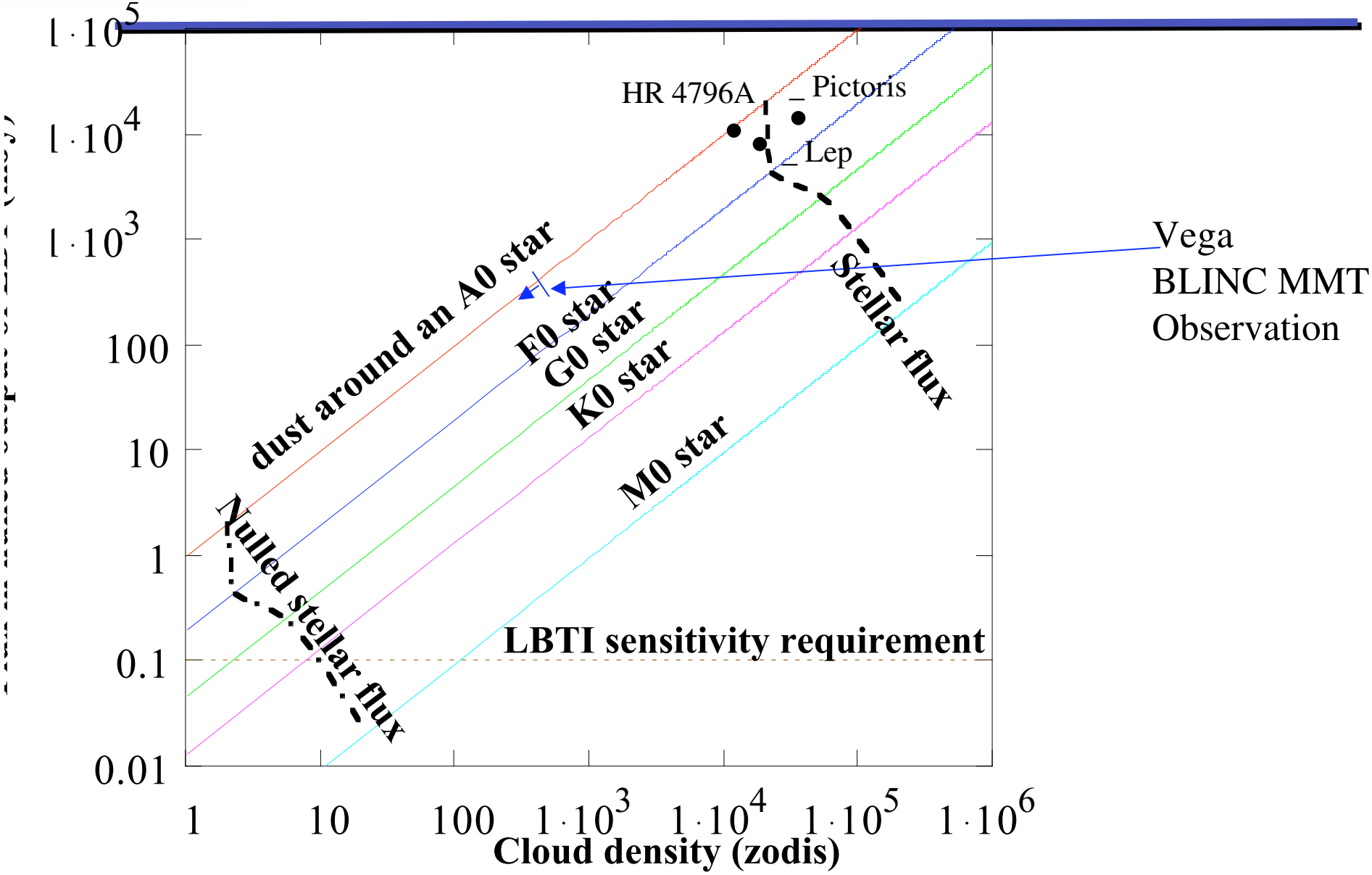
- Provide sensitive nulling interferometric observations of nearby solar-like stars (the NIREST survey).
- Provide beam combination compatible with wide-field Fizeau (imaging) interferometry (imagers not part of the project).
- Develop the technique of nulling interferometry, active phase control, and observing strategies.
- Provide a test-bed for multi-pair nulling techniques which can verify the optical systems of a TPF mission.

A Nulling Infrared survey of Extra-solar Systems for TPF (NIREST)

The LBTI NIREST survey will be an important scientific step in understanding what exists around potential candidate stars for the Terrestrial Planet Finder Mission (TPF). Do they have zodiacal dust disks? Gas giant planets?

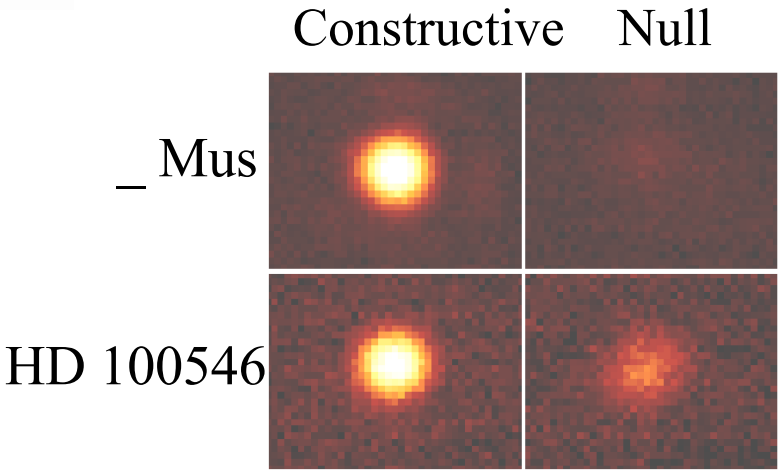
- Zodiacal dust disks signal the existence of planetary systems and provide information about their placement.
- Giant planets, similar to Jupiter, dominate the dynamical environment of potential terrestrial planets. As such, their existence and placement in a planetary system are important for determining the habitability of a system.
- The survey goal is to observe ~80 stars to begin to understand what the zodiacal dust strength is for stars as a function of their spectral type and age.

Probing dust limits for stars at 10 pc



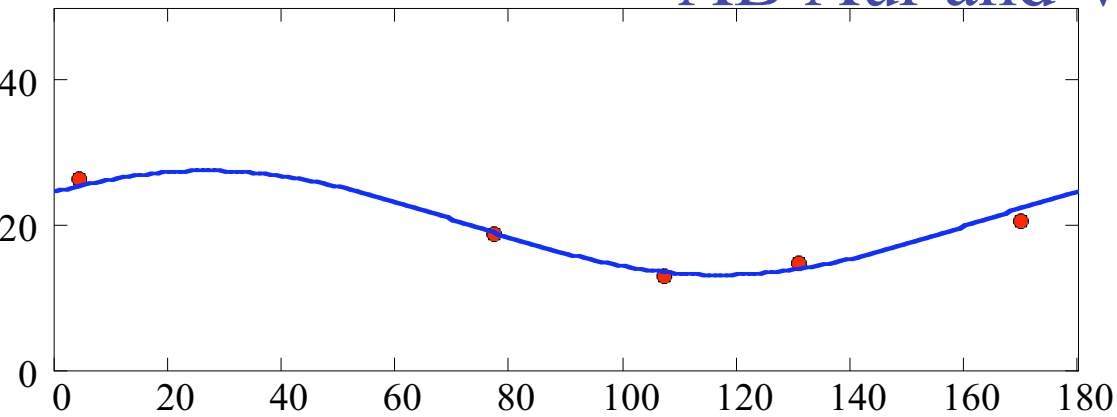
Science Results using a prototype nuller on the MMT

HD 100546 (Liu et al. 2003, (ApJL 598, 111))



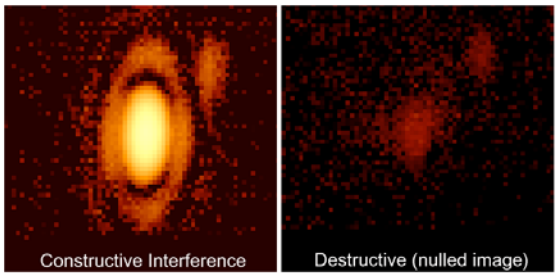
- Disk approximately 25 AU in diameter.
- Disk similar in size at 11 microns and 24.5 microns.
- Consistent with an inner hole? (Bouwman et al. 2003)

AB Aur and V892 Tau (Liu et al. ApJL accepted)



- AB Aur Disk ~32 AU.
- Disk inclined at 45 degrees.
- V892 Tau size ~22 AU.

Vega (Liu et al. 2004, (ApJL 610, 125))



- Upper limit to zodiacal dust is <2% (3 _) of the stellar flux on Vega, ~3 times more sensitive than best photometric measurements.
- Corresponds to a limit of a zodiacal dust disk <650 times our own.

LBTI Accommodates Anticipated Fizeau Imaging

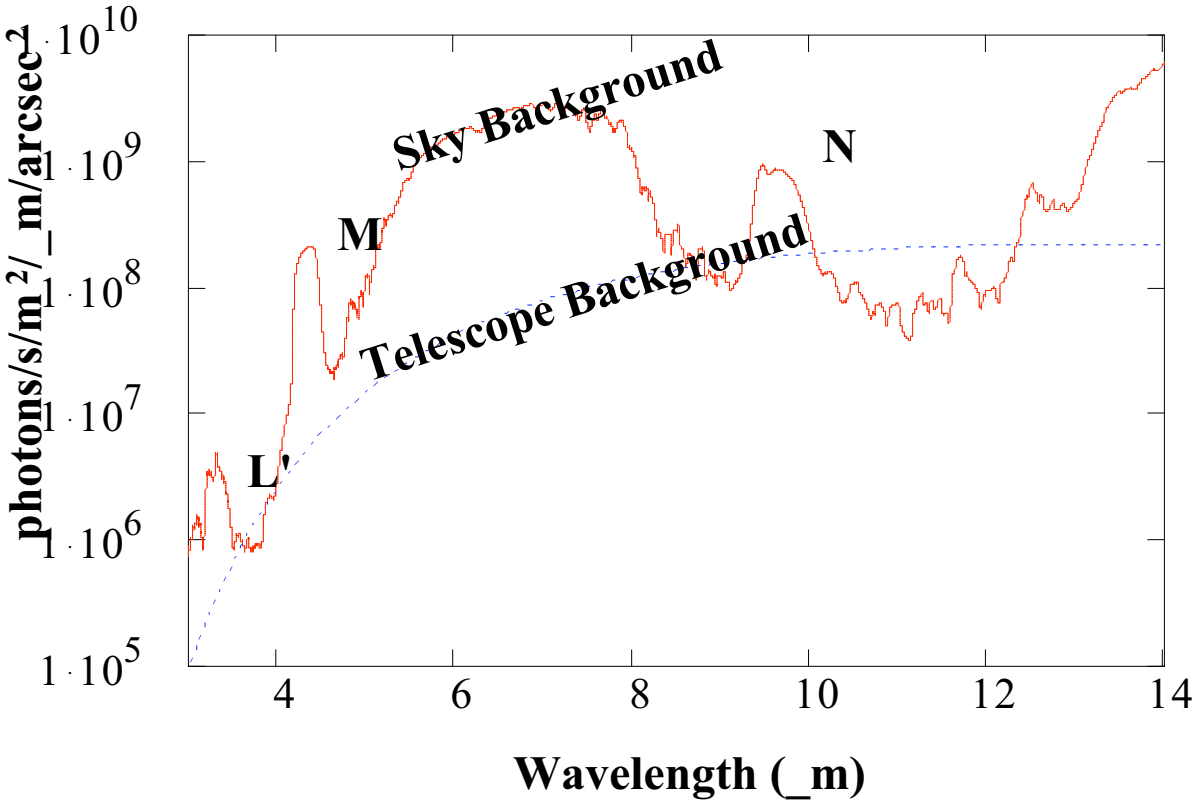
- The requirements for nulling interferometry with the LBT are consistent with the design requirements for wide-field imaging (or Fizeau) interferometry.

- This technique allows high resolution (0.01-0.05”) imaging of even faint objects over wide (30-40”) fields of view.

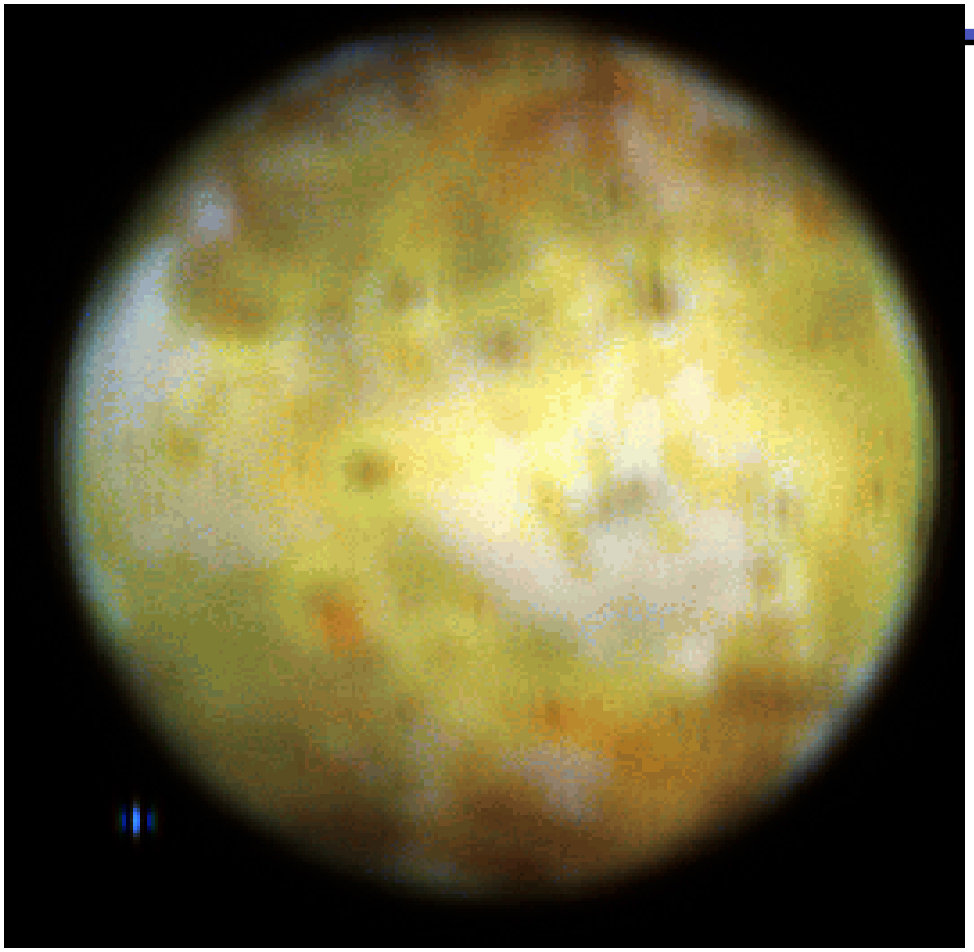
- The LBTI design preserves this capability over a broad range of wavelengths in the near and mid infrared (1-20 microns).
  - Fizeau imagers and phase sensing to take advantage of this are not within the scope of the LBTI program.

LBTI Imaging Sensitivity

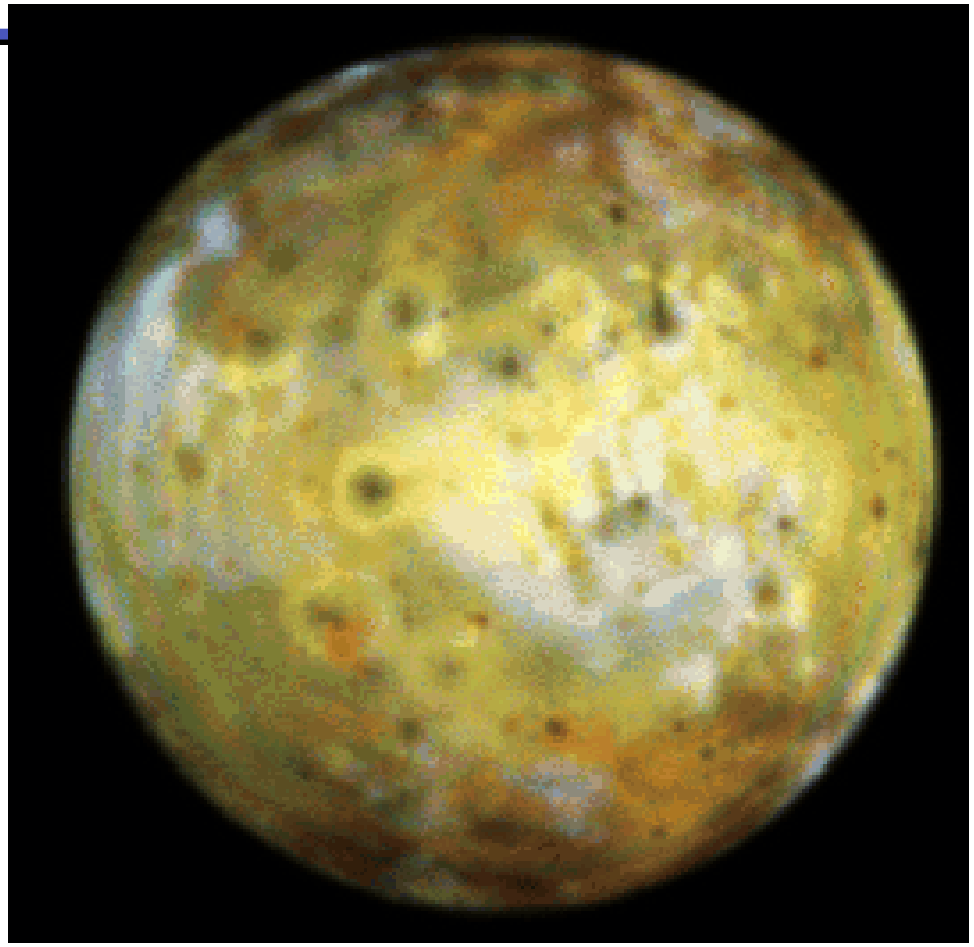
Band	1 hour, 5_ detection limit _Jy (mag.)	
K (2.2 _m)	0.06	(25)
L' (3.8 _m)	1.7	(20.5)
M (4.8 _m)	18	(17.3)
N (10.6 _m)	70	(14.3)
Q (18.0 _m)	350	



LBTI Fizeau Imaging Capabilities



Fizeau imaging snapshot of Io

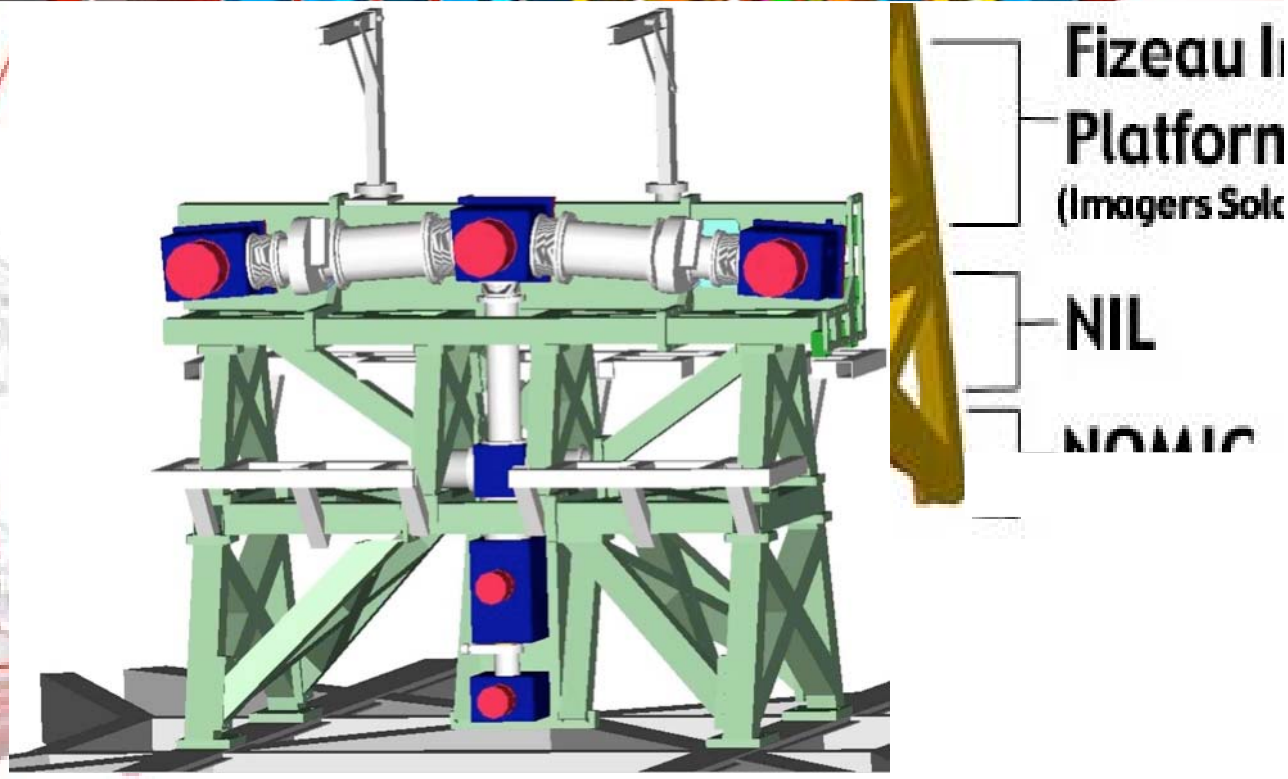


Reconstruction from three images formed at 60 degree intervals

resolution appropriate for I, J, & H bands (simulation by Keith Hege)

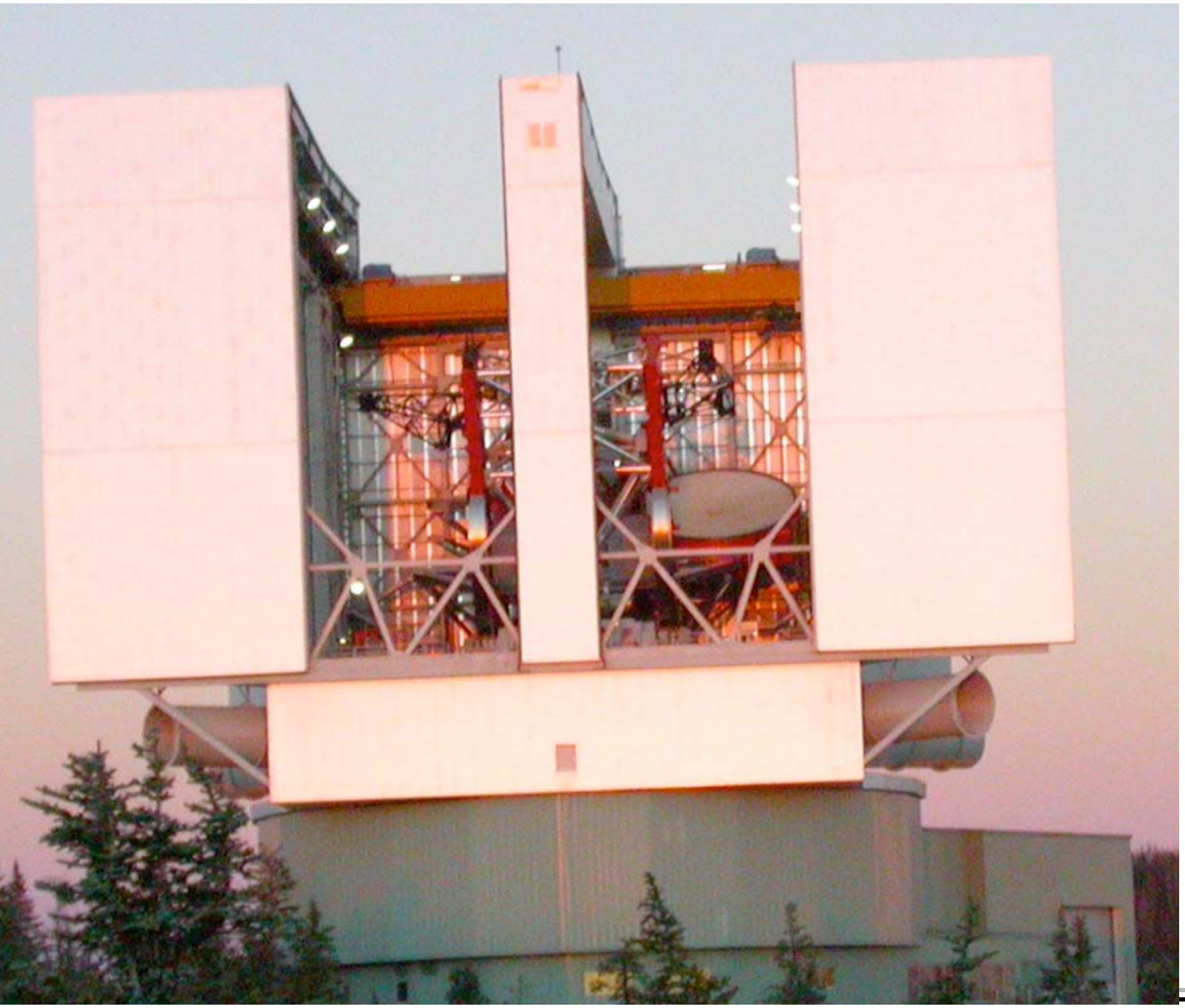
The LBT Interferometer (LBTI)

LBTI on the telescope



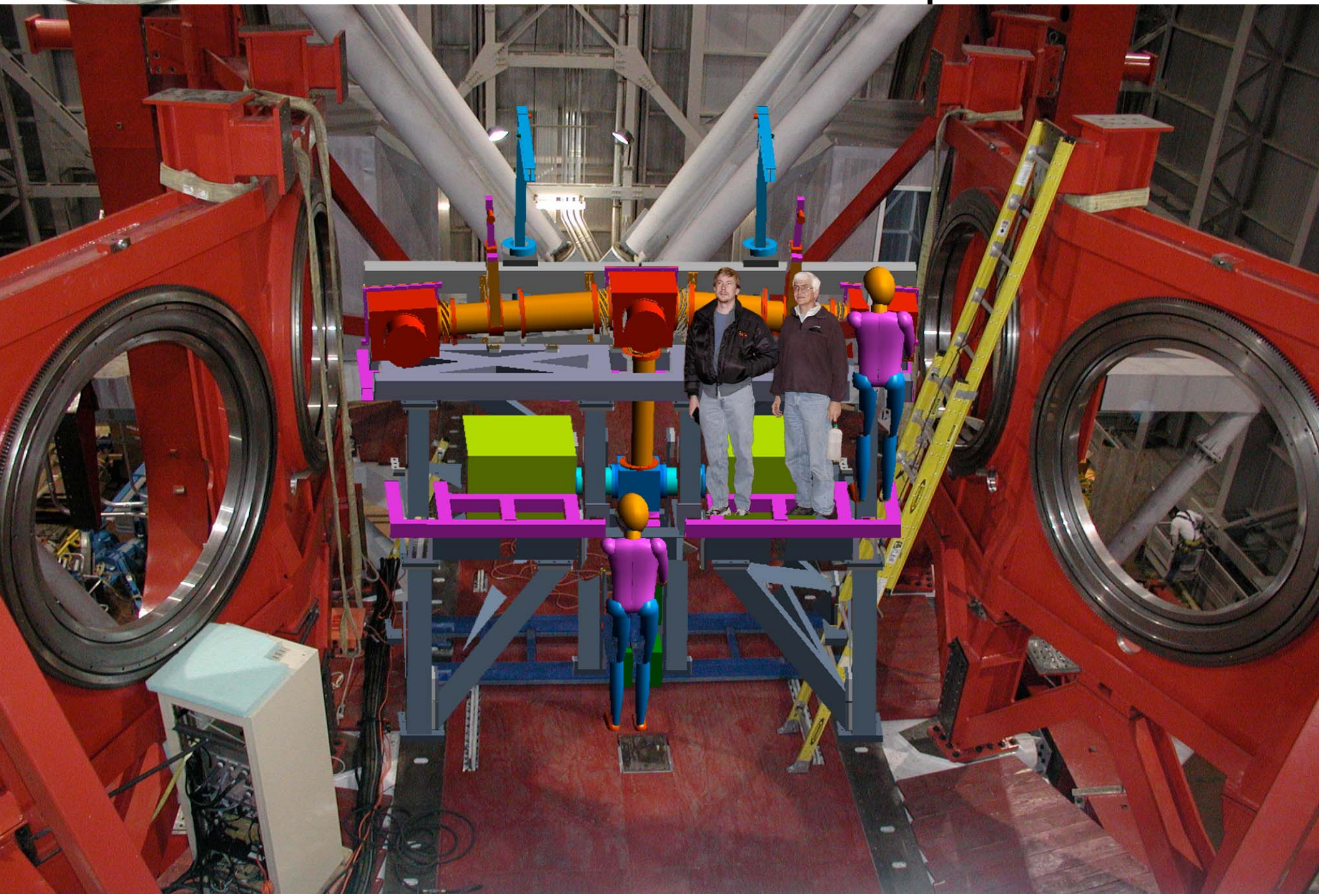
UBC=Universal Beam Combiner
NIL=Nulling Interferometer for the LBT
NOMIC=Nulling-Optimized Mid-Infrared Camera

Testing the first primary



- First light testing is currently underway
- Adaptive Secondaries will be integrated in ’06.

The LBTI on the Telescope



LBTI metering structure

LBTI Parts 07/04

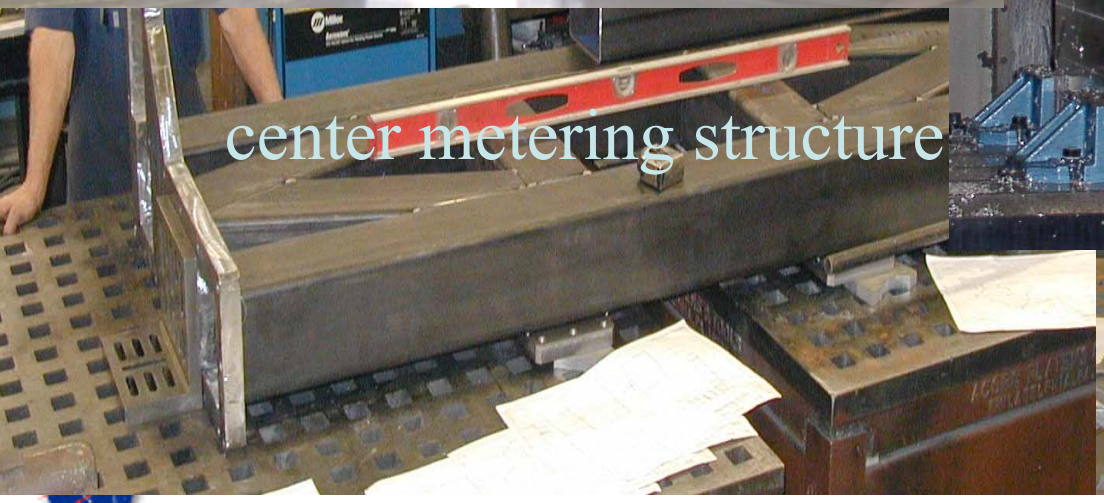
Reimaging Mirror


vacuum bellows


rough cryostat housing

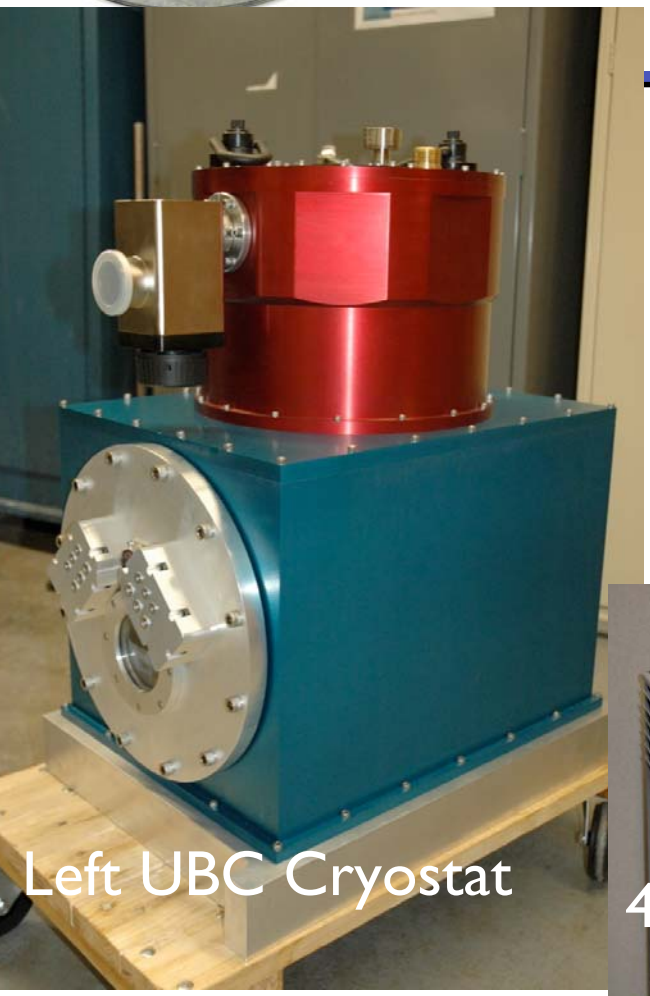

Mirror being polished

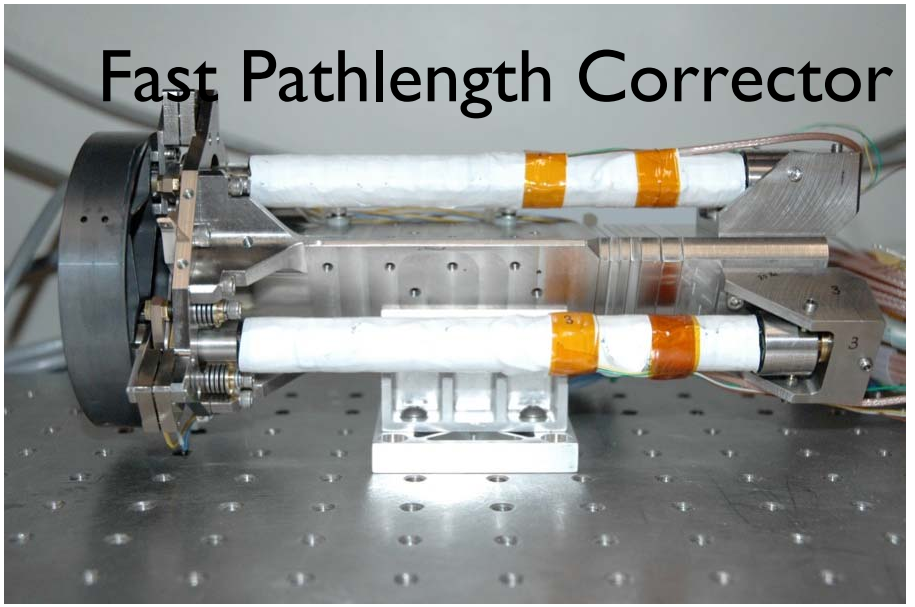

cryostat housing machined


center metering structure

metering structure edge-on

LBTI Components 02/05





Conclusion

- LBTI is an important stepping stone for TPF. It will allow NASA to verify the techniques for planet finding and better understand candidate target systems with the lower risks and costs of a ground-based instrument.

- The LBTI is very close in design to an interferometric TPF needing to solve many of the same technical problems, while avoiding those issues unique to ground-based long baseline interferometers.

- The prototype instrument, BLINC with the MMT AO system, is allowing us to develop a mature technique in preparation for the LBTI.